AFOSR-TR-97-0456

# REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188



| 1. AGENCY USE ONLY (Leave blank) | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | May 29, 1997 | Final Technical Report 1993-1997 |

**4. TITLE AND SUBTITLE**
AASERT : Investigation of Whistler Wave Phenomena

**5. FUNDING NUMBERS**
F49620-93-1-0385

**6. AUTHOR(S)**
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**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
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**8. PERFORMING ORGANIZATION REPORT NUMBER**
N/A

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
Air Force Office of Scientific Research, AFOSR /NM
110 Duncan Ave., Suite B115
Bolling Air Force Base, D.C. 20332-001

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**
Complete technical details contained within separate Final Technical Report for AFOSR F49620-93-1-0071: Collisionless Dynamics of the Magnetosphere.

**12a. DISTRIBUTION/AVAILABILITY STATEMENT**
DISTRIBUTION UNLIMITED

**12b. DISTRIBUTION CODE**

19971003 060

**13. ABSTRACT** (Maximum 200 words)

[Abstract for AASERT Award Number F49620-93-1-0385]

This award supported research to develop physics-based models of energetic particle transport induced by fluctuations with complex, time-evolving frequency spectra. New observations were made using the Collisionless Terrella Experiment (CTX), and a variety of experimental and computation techniques were developed. By combining detailed laboratory measurements of the global structure of intense plasma fluctuations with nonlinear guiding-center Hamiltonian simulations, the relationship between induced radial transport and the spectral intensity of drift-resonant fluctuations was demonstrated for the first time. This award provided research and educational support for three undergraduate students and four graduate students.

| 14. SUBJECT TERMS | 15. NUMBER OF PAGES | 16. PRICE CODE |
|---|---|---|
| | 3 | |

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
|---|---|---|---|
| unclassified | UNCLASSIFIED | UNCLASSIFIED | unlimited |

# Final Technical Report
# AASERT Award Number F49620-93-1-0385

TITLE OF RESEARCH PROGRAM: Investigation of Whistler Wave Phenomena

SUBMITTED BY: Michael E. Mauel, Professor
Department of Applied Physics
Columbia University, New York, NY 10027

## Introduction

This award supported research to develop physics-based models of energetic particle transport induced by fluctuations with complex, time-evolving frequency spectra. New observations were made using the Collisionless Terrella Experiment (CTX), and a variety of experimental and computation techniques were developed. By combining detailed laboratory measurements of the global structure of intense plasma fluctuations with nonlinear guiding-center Hamiltonian simulations, the relationship between induced radial transport and the spectral intensity of drift-resonant fluctuations was demonstrated for the first time. This award provided research and educational support for three undergraduate students and four graduate students.

The research funded with this award has been exciting and successful. For the first time, chaotic transport of energetic particles trapped in a dipolar magnetic field induced by drift-resonant plasma waves has been observed in the laboratory. In support of these activities, students have been designing and constructing new diagnostics, performing experimental runs, and analyzing experimental data with computer simulations. In addition, several presentations and publications were prepared.

A complete technical report of research results from this award has been prepared for AFOSR Award Number F49620-93-1-0071, "Collisionless Dynamics of the Magnetosphere."

## Students Supported with this Award:

Harry Warren — Graduate Student

> Dr. Harry Warren completed his doctoral dissertation with support from this award. Harry Warren discovered and explained the source of strong temporal modulations of energetic particle flux induced by After delivering several invited presentations and winning praise for his accomplishments, Dr. Warren is now conducting solar research at the Naval Research Laboratory.

Patrick Paraggio — Graduate Student

Patrick Paraggio completed his Master of Science degree and is now working at the IBM East Fishkill facility in plasma processing.

Scott Taormina — Graduate Student

Scott Taormina completed his Master of Science degree and is now working at Lam Technologies—one of the world's leading manufacturer of plasma processing tools and equipment for semiconductor production.

Dylan Brennan — Graduate Student

Dylan Brennan complete his Master of Science degree and will begin a doctoral program in plasma physics at University of Manchester in the U.K.

David W. Blaschak — Undergraduate Student

David Blaschak constructed and tested three capacitive probes and three Langmuir probes. He also designed and built an photo-detector amplifier circuit, a piezo-electric gas valve pulser, and a Langmuir probe bias box. He has performed systematic calibrations of gas injection and plasma performance optimizations. David Blaschak was honored by Columbia University for outstanding scholarship, and he is now an assistant crew coach at a major university.

Albert Chow — Undergraduate Student

Albert Chow designed, tested, and constructed a 36-channel transimpendance amplifier for a novel polar particle imaging diagnostic. Albert Chow is still a straight-A student at Columbia University.

Arron Winninger — Undergraduate Student

Arron Winninger designed software for the measurement of the background plasma electron temperature and density. Mr. Winninger is now study at Fordham's Law School and will pursue a career in patent law.